EXPLANATION OF PLATES.

PLATE III.

Fig. 1. Lambrachæus remifer, ♂.
„ 2. Physachæus ctenurus, ♂; 2*a*. abdomen of ♀ × 4; 2*b*. abdomen of ♂ × 4.
„ 3. Physachæus tonsor, ♀
„ 4. 4*a*. Grypachæus hyalinus, ♀.

PLATE IV.

Fig. 1. 1*a*. Inachoides dolichorhynchus, ♂.
„ 2. 2*a*. Apocremnus indicus, ♂.
„ 3. Naxia investigatoris, ♂.
„ 4. Macrocœloma nummifer, ♂.
„ 5. Maia gibba, ♂.

PLATE V.

Fig. 1. Achæus cadelli, ♂.
„ 2. 2*a*. Chorilibinia andamanica.
„ 3. Callodes malabaricus, ♀.
„ 4. 4*a*. Paratymolus hastatus, ♀.

On Polarisation of Electric Rays by Double Refracting Crystals.—*By* PROF. J. C. BOSE, B.A., (CANTAB.) B. SC. (LOND.)

[Read 1st May.]

Plate VI.

A ray of ordinary light incident on a crystal of Iceland spar is generally bifurcated after transmission, and the two emergent rays are found polarised in planes at right angles to each other. The object of the present inquiry is to find natural substances which would polarise the transmitted electrical ray. It was thought that the analogy between electric radiation and light would be rendered more complete, if the classes of substance which polarise light were also found to polarise the electric ray. The identity of the two phenomena may be regarded as established, if the same specimen is found to polarise both the luminous and electric rays.

As the wave length of an electrical ray is very large compared with that of visible light, one would think very large crystals, much larger than what occur in nature, would be required to show polarisation of electric rays. By working with electric radiations having very short wave lengths, I have succeeded in obtaining very satisfactory results with crystals of moderate size. These experiments show that certain crystals are double refracting as regards electric rays, and that they polarise the transmitted beam. With the help of a rudely constructed apparatus, I was able last year to detect traces of these effects. The apparatus has since been improved in detail; it is now possible to detect the polarisation effects with certainty.

The usual optical method of detecting the bi-refringent action of crystals, is to interpose the double refracting structure between two crossed Nicols. The interposition of the crystal generally brightens the dark field. This is known as the depolarising effect, and is regarded as a delicate test for double refracting substances. There is however, no depolarising effect, when the principal plane of the crystal coincides with the polarisation planes of either the polariser or analyser. The field also remains dark, when the optical axis of the crystal is parallel to the incident ray.

A similar method was adopted for experimenting with polarised electric radiation. The electric ray is first polarised by a wire grating. A similar grating acts as an analyser. The two gratings are crossed, and the crystal to be examined is interposed. The Receiver is a modified form of 'Coherer' with its associated Voltaic cell and Galvanometer. Brightening of the field is indicated by a throw of the Galvanometer needle.

Apparatus used.

Radiator.—A small Ruhmkorff's coil is used for the production of oscillatory discharges between two small metallic spheres, the diameter of each sphere being 1·5 c. m. The choice of a coil to produce electric oscillation has been a matter of necessity. I obtained oscillatory effects with ease and certainty by using a small influence machine of the Replenisher type. But in the damp atmosphere of Calcutta, the satisfactory working of such a machine is a matter of great difficulty, at least for the greater portion of the year. I had therefore to abandon the influence machine with regret, and to use a Ruhmkorff's coil instead. This coil caused me the greatest trouble. The discharge would of a sudden cease to be oscillatory; after a great deal of coaxing it would work satisfactorily just for a short time. The only coil I could get, was a badly constructed one, with defective insulation. I made it serviceable by changing the condenser and improving the vibrator. By looking to many points of detail I succeeded in making the apparatus work with fair uniformity for several hours. It must be borne in mind that the Receiving apparatus also requires careful adjustment.

Among the possible causes of unsteadiness may be mentioned the following—

1st. The current actuating the coil may vary after a time. To overcome this difficulty a fairly constant battery was made to charge a small storage cell, and a derived circuit from this cell was led to the Primary coil.

2nd. The interrupter may have its rate of vibration changed by heating, wearing out of contact points, and other causes. Any change in the periodicity of the vibrator is at once made evident by the corresponding change in the pitch of the note given out by the vibrator.

3rd. The sparking balls may have their surfaces roughened by the disintegrating action of the spark. To avoid this difficulty, the balls were thickly coated with deposit of gold, and were turned round at intervals to expose fresh surfaces.

The coil with a storage cell is enclosed, with the exception of a horizontal tubular opening, inside a metallic box, not dissimilar in appearance to an Optical Lantern. The interrupter is actuated by turning a key from outside. The sparking balls are at one end of a brass tube 25 c.m. long and 5 c.m. in diameter. At the further end of the tube is the Polariser. Inside the tube is placed a convex lens with the spark gap at its principal focus. With the help of the lens and suitable diaphragms, the electrical beam is made approximately parallel. By means of an Iris diaphragm, the amount of radiation may be varied.

Polariser.—The success of the experiment depends greatly on the care with which the Polariser and Analyser are constructed. Fine copper wire ·2 m. m. in diameter is carefully wound in parallel lines, round two thin sheets of mica. There are about 25 lines for every centimetre. The mica pieces are then immersed in melted paraffin, and the wires thus fixed *in situ.* By cutting round, two circular pieces, containing the gratings are obtained. The mica pieces are too thin to produce any disturbing effect. The gratings are fixed with wires parallel, at the ends of a tube 5 c.m. long. This Polariser tube rotates inside the outer end of the tube which sends out the parallel electric beam.

Analyser.—The Analyser is similar in construction to the Polariser. It rotates inside the Receiving tube, which contains the sensitive surface for detecting radiation.

Receiver.—The Receiving apparatus consists of a 'Coherer' with a Voltaic cell and Galvanometer in series. The Coherer is modified from its usual tubular form. The filings, a single layer thick, are spread over a large surface. This arrangement secures great sensitiveness. A pair of insulated wires from the ends of the Coherer, are led out to a distant dead-beat Galvanometer of D'Arsonval type in series with a constant cell. The leading wires are shielded from radiation by enclosing them inside two coatings of tin foil, along the whole length. As an additional precaution the Galvanometer is also enclosed in a metallic case, with a slit in front of the Galvanometer mirror. A spot of light reflected from the mirror is received on a scale. By adjusting the electromotive force of the circuit, the sensitiveness may be increased to any extent desirable.

When the Analyser and Polariser are properly constructed, and the two exactly crossed, no radiation will reach the sensitive surface, and the Galvanometer will remain unaffected. The field is then said to be dark. But any slight rotation of either Polariser or Analyser, will partially restore the field, and the spot of light will sweep across the scale.

Method of Experiment.

The spark gap 2 m.m. in length is adjusted in a line inclined at 45° to the horizon. The wires of the Polariser are placed at right angles to this line. The transmitted beam is then plane polarised, its plane of vibration being inclined at 45° to the horizon. The Analyser is now adjusted in a crossed position. On starting the electric vibration, by closing the Ruhmkorff's coil circuit, the Galvanometer remains unaffected. The crystal to be examined is now interposed with its principal plane vertical.

The Geological Department of India kindly lent me a large number of crystals for examination, for which I have to express my thanks. Out of a large number of experiments, I give below an account of some typical cases.

Rhombohedral System.—1° *Beryl.*—The first piece experimented on was a large crystal of Beryl. It is a Hexagonal prism with basal planes. The specimen examined has each face 11 × 5 c.m. The three axes lying in the same plane are inclined at 60° to each other, the fourth axis which is also the optical axis, is at right angles to the plane containing the other three. This crystal was optically opaque.

On interposing this block with its principal plane vertical, the Galvanometer spot flew off the scale. The crystal had thus produced the well known depolarising action. The crystal was now gradually inclined till its principal plane coincided with the polarising plane of the Polariser. There was now no action on the Galvanometer. On continuing the rotation the Galvanometer at once responded. The spot became quiescent a second time, when the principal plane coincided with the polarisation plane of the analyser.

The crystal was now placed with its optic axis parallel to the direction of the incident ray. There was no action on the Galvanometer. Rotation of the crystal round this axis, did not produce any effect on the Galvanometer. The field continued to be dark.

2° *Apatite.*—This specimen exhibited decided double refraction.

3° *Nemalite.*—This is a fibrous variety of Brucite. This specimen exhibited a very strong depolarisation effect. It also exhibited certain interesting peculiarities which will form the subject of a future communication.

Rhombic system.—A large piece of Barytes was found strongly double refracting.

Triclinic system.—Microcline, a greenish blue crystal of the double oblique type, exhibited polarisation effect to a remarkable degree.

Regular system.—A large crystal of Rock-salt was taken. This as was expected did not produce any effect.

Having satisfied myself of the fact that systems of crystals other than regular, produce double refraction and consequent polarisation of electrical ray, I tried the action of electric radiation on crystals ordinarily used in optical experiments.

I got a fairly large piece of black Tourmaline. On interposing this with its plane vertical, there was prompt movement of the spot of light. There was no action on the Galvanometer, when the principal plane coincided with the planes of polarisation of either the Polariser or Analyser.

With ordinary light a piece of Tourmaline of sufficient thickness absorbs the ordinary, but transmits the extraordinary ray. With the piece of Tourmaline used in the last experiment I found both the rays transmitted, but, it seemed to me, with unequal intensities. In other words, one ray suffers greater absorbtion than the other. It seems probable that with greater thickness of crystal one ray would be completely absorbed. I found other crystals behaving more or less in the same way. I reserve for another communication particulars of experiments bearing on this subject.

Lastly I tried an experiment with a crystal of Iceland spar, taken out of a Polarising apparatus. With this I got distinct depolarising action.

The above results, with the exception of the last, were obtained with uncut specimens. Their faces were often rough and irregular. Better results, were they needed, could no doubt be obtained by judicious cutting and polishing the faces.

Summary.—It will thus be seen that crystals which do not belong to the Regular system, polarise the electric ray, just in the same way as they do a ray of ordinary light. Theoretically all crystals, with the exception of those belonging to the Regular system, ought to polarise light. But this could not be verified in the case of crystals opaque to light. There is no such difficulty with electric rays, for all crystals are transparent to them. As a matter of fact, all the above experiments with one exception were performed with specimens opaque to light.

Explanation of the plate

R ... metallic box containing the Ruhmkorff's coil.
S ... position of the sparking balls.
L ... position of the convex Lens.
P ... the Polariser.
I ... Iris diaphragm.
K ... the Crystal.
A ... the Analyser.
C ... the Coherer.
G ... the Galvanometer. In practice the Galvanometer is placed at a greater distance and the leading wires enclosed in tin-foil.

Description of a New Species of Oxyrhynch Crab of the Genus Parthenope.

—By A. Alcock, M. B., C. M. Z. S., *Superintendent of the Indian Museum.*

[Read 3rd July.]

The species here described is a true *Parthenope* as delimited by Miers, Journn. Linn. Soc., Zool., Vol. XIV. 1879, p. 668.

Parthenope investigatoris, n. sp.

Carapace almost equilaterally triangular, the sides very slightly curved: its surface is deeply eroded and rugose as in *P. horrida* and *spinosissima,* but is almost devoid of the sharp tubercles found in those species: the antero-lateral borders are slightly crenulate: the produced postero-lateral angle is rounded and nearly smooth: the posterior border bears five small eroded lobules—a very small one in the middle line, with two larger ones on either side—with intervening granules. The gastric region is enormously inflated as in *P. spinosissima,* and descends almost vertically to the vertically deflexed rostrum, the latter being fused with the interantennulary